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ABSTRACT

A summary and an analysis of the findings of the Land Resources for Populations of the Future project are provided in this report. The project, conducted by the Food and Agriculture Organization, studied the food production capabilities of 117 developing countries to determine how many people they could support at different levels of farming and to compare that with each country's population in 1975 and projected population in 2000. Among the findings are that at low levels of farming (the current practice in most developing countries), 38 percent of these areas could not support their 1975 population and 65 countries will be unable to feed their population in the year 2000. Regional findings are presented for Africa, Asia, Latin America, and Southwest Asia (Middle East) accompanied by maps which illustrate the situation relative to 1975 populations. The analysis of the project points out some overly optimistic assumptions upon which the study was based such as that all cultivable land would be used, that it would be used only to grow food crops, and that food supplies would be distributed equally among socioeconomic groups. The conclusion of the analysis is that the problem is even more critical than the study shows. (DC)

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Land and People, the Growing Pressure

by

Paul Harrison

Earthwatch, n13, 1983

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EARTHWATCH

Land and people, the growing pressure

Many Third World countries will exceed the limits of their land's carrying capacity by the year 2000 if they do not face up to their population/resources equation. This is one of the main conclusions of this special *Earthwatch* report on the findings of the Land Resources for Populations of the Future project. Based on data from 117 countries, this scientific study suggests that there are real limits to food production – and that the population of some countries is already greater than their land can support.

by Paul Harrison

At subsistence levels of farming, the entire cultivable lands of the developing world – three or four times the present cultivated area – would barely be able to support the expected population for the year 2000. Sixty-five countries would be unable to feed their population from their own lands at the end of the century.

These are the most alarming findings of a new study of land resources and population-supporting capacity in 117 countries, carried out by the Food and Agriculture Organization with funding from the United Nations Fund for Population Activities, the final report of which will be published later this year.

Paul Harrison is the author of *Inside the Third World* and *The Third World Tomorrow* (Penguin, 1980). He is currently working as a consultant to FAO for the Land Resources for Populations of the Future project.

How it was done

The methodology of the study was extremely complex. The detailed FAO/UNESCO World Soil Map (scale 1:5,000,000) provided localized data on soil types, the slope of the land, and other physical characteristics that affect productivity. A separate climate map was prepared, based on patterns of rainfall, temperature and solar radiation, which divided the developing world into major climates and into many hundreds of 'length of growing period zones' – areas within which conditions were suitable for plant growth for a given number of days in the year (for example, 0-75 days, 75-90, 90-120 and so on).

The crucial step was to superimpose the climate map over the soil map, thus producing a fine mosaic of tens of thousands of land units with distinctive land and climate characteristics. For each cell in this mosaic, a complicated computer programme (designed and run by the International Institute for Applied Systems Analysis in Vienna) calculated the potential yields for every one of the major food crops that could be grown there.

The one crop that gave the optimum yield was selected for each area, and the yield in terms of calories calculated. These finely detailed results were then clumped together, by country, by climate and by length of growing period zone. The calorie production of each area was converted into a figure for population carrying capacity simply by dividing by the average recommended calorie intake for each country.

Comparison with the 1975 populations enabled the project to pinpoint which areas could not support their populations, while comparison with populations expected on the UN medium variant in the year 2000 made it possible to predict which countries and regions would be critical in the future.

Because farming practices such as fertilizer use have a strong effect on yields, all the calculations were done for three levels of farming: a *low level* of inputs – roughly what you might find in a rural area of a Least Developed Country – using no fertilizer or chemicals, traditional seed varieties and cropping patterns, and no conservation measures; an *intermediate level*, using a basic package of fertilizers and chemicals, with some improved varieties, simple conservation measures, and the most productive crop mix on half the land – this level might correspond to that found among medium and small farmers in development project areas in Asia. And a *high level* of farming, corresponding roughly to North America, with high doses of fertilizer, full use of chemicals, improved varieties and conservation practices, and the ideal mix of crops on all the land.

There was no attempt in the first phase of the project to decide where individual countries or regions came on this scale. But most farmers in Africa would be at the low level of input use; in Asia and Latin America commercial farmers might be at the intermediate level, but the majority of small farmers would be somewhere between low and intermediate.

There was also no attempt to assess whether countries unable to produce sufficient food from their own land possessed – or could develop – secure sources of foreign exchange with which to buy imported food. For those that have such sources, inability to feed their population from their own land is less of a problem.

The study is the most thorough and scientifically based effort so far undertaken to determine just how much food the lands of the developing countries are capable of producing and how many people they could feed at different levels of farming. It is based on detailed soil and climate maps and the growth patterns and requirements of 18 major food crops (see 'How it was done' above).

Its findings, the outcome of more than a decade of preliminary work in the Land and Water Division of FAO, present an unanswerable challenge to the fashionable school of thought which holds that there are no limits to food production except those deriving from social and economic structures, and ☞

there is no such thing as overpopulation.

Looked at on a global scale, the results look misleadingly reassuring (see Tables A and C, page 2). Even at low farming levels, the lands of the developing countries studied (East Asia and a few small islands were not included) could support one and a half times their expected populations for AD 2000. With intermediate inputs, they could support four times the expected numbers, and with high inputs no less than nine times.

But the closer the results come to national and local levels, the more alarming do they become. The regional picture is cause for concern in Africa, which with low inputs could support only one and a half times its year 2000 populations; in Central America and the Caribbean, which could support 1.4 times the expected numbers; and in Asia (1.1 times).

Only one region, South-west Asia (the Middle East), would be unable to feed its population at the end of the century, even with intermediate inputs, but with high inputs could just about manage.

In the other regions, raising the level of inputs allows much higher population-supporting capacities. With high inputs, the lands of Asia could feed 3.3 times their year 2000 populations, those of Central America six times, while Africa could feed 16 times and Latin America no less than 32 times the projected populations. The message of these results is that a much greater measure of regional food self-sufficiency is possible in the developing world.

The regional figures assume a completely free movement of surplus food across national frontiers, regardless of ability to pay. A more realistic guide to the true impact of the problem is provided by the results at country level. These show that by the year 2000 no less than 65 countries, with a population of 1,065 million (29 per cent of the total), will be unable to feed their population from their own land with the low level of inputs. The number of people in excess of their carrying capacity would be 440 million. Some 30 of these critical countries would be in Africa (out of a regional total of 51 countries); 15 would be in South-west Asia (out of 16); 14 would be in Central America and the Caribbean (regional total 21); and six in Asia (out of 16). None of the 13 countries in South America would be critical.

Raising the level of farming has a dramatic effect on the results. Twenty-nine of the 65 critical countries would cease to be so if they could achieve intermediate inputs, while another 17 could become self-sufficient in food if they could reach high levels of inputs. But 19 countries, with a total population of 104 million, would remain unable to feed their year 2000 populations even with the most advanced farming methods. Twelve of these would be in South-west Asia.

Thus, the potential for food production, and therefore the capacity to support populations from the land, is very unevenly distributed between countries. The emergence of fixed national boundaries has made the problem much more intractable than it might have been in the past. For example, five countries in East Africa will be critical in AD 2000 even with intermediate inputs, yet they are close to countries in Central Africa that could support 13 or more times their expected populations with intermediate inputs. In the 19th century, farmers from the overcrowded hills of Rwanda or Burundi would simply have migrated

Population supporting ratios

The figures in these tables indicate the number of times by which the potential population carrying capacity of the land exceeds the actual or expected population for the year stated.

Input level	Africa	Asia	SW Asia	South America	Central America	Total
A. Year 1975 populations, all cultivable land under food crops.						
Low	2.7	1.1	**0.8**	5.9	1.6	2.0
Intermediate	10.8	3.0	1.3	23.9	4.2	6.8
High	31.6	5.1	2.0	57.2	11.5	16.3
B. Year 1975 populations, actually cultivated land, one-third under non-food crops.						
Low	**0.4**	**0.7**	**0.8**	**0.6**	**0.5**	**0.4**
Intermediate	1.5	1.9	1.2	2.4	1.3	1.5
High	4.5	3.1	1.9	5.8	3.7	3.6
C. Year 2000 populations, all cultivable land under food crops.						
Low	1.5	1.1	**0.7**	3.5	1.4	1.5
Intermediate	5.4	2.3	**0.9**	13.3	2.6	4.1
High	15.6	3.3	1.2	31.5	6.0	9.1
D. Projected stable populations in 2150, all cultivable land, one-third under non-food crops.						
Low	**0.4**	**0.4**	**0.3**	1.5	**0.6**	**0.5**
Intermediate	1.4	**0.9**	**0.3**	5.5	1.1	1.44
High	4.2	1.3	**0.5**	13.1	2.5	3.2

Bold type indicates critical figures, where region cannot support its population. But any figure below 2 indicates a tight situation.

Source: A and C: Land Resources for Populations of the Future, FAO, 1983
B and D: Author's estimates.

What the maps show

The maps illustrate those areas that could not support their 1975 populations even if all the cultivated land within them were used to grow nothing but food crops. The level of farming inputs implied here is the low level – corresponding to the practice of most subsistence farmers in developing countries today. The total extent of these critical areas amounts to 2,480 million hectares – 38 per cent of the total land area of the 117 countries studied. The combined population of the critical areas was 1,144 million – 58 per cent of the total – of whom 544 million were in excess of the carrying capacity of the land.

Africa

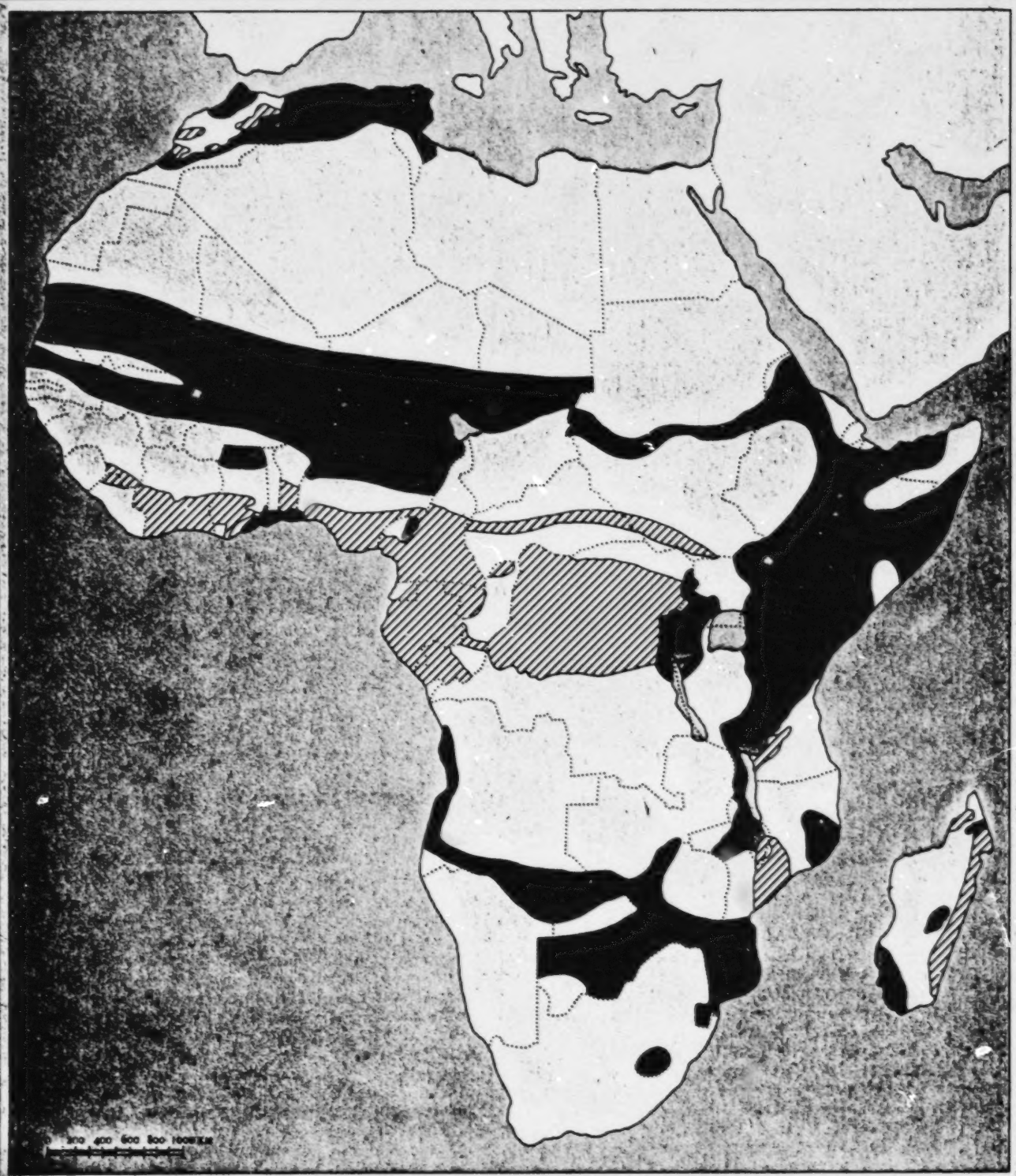
Land able to support more than one person per hectare with low inputs.

Land where the potential carrying capacity, at low inputs, is less than the present population.

Africa represents the most serious challenge, for of all regions the continent has the lowest levels of farming, the least developed alternative sources of income to buy food imports, and will have the fastest rates of population growth after the year 2000. The entire lands of the whole continent could support one and a half times the total expected population in AD 2000, even with low inputs. But a great deal of the potential is concentrated in a few sparsely populated countries in Central Africa. Almost half the total land area could not support even its 1975 population with low inputs. The critical areas include much of North Africa, almost the whole of the Sahel, the most densely populated parts of East Africa, and the dry zone straddling Southern Africa.

By the year 2000, no less than 30 countries out of 51 in the region will be unable to feed their populations with low inputs. Their total populations will be 477 million – 58 per cent of the regional total – of which more than half would be in excess of the land's carrying capacity.

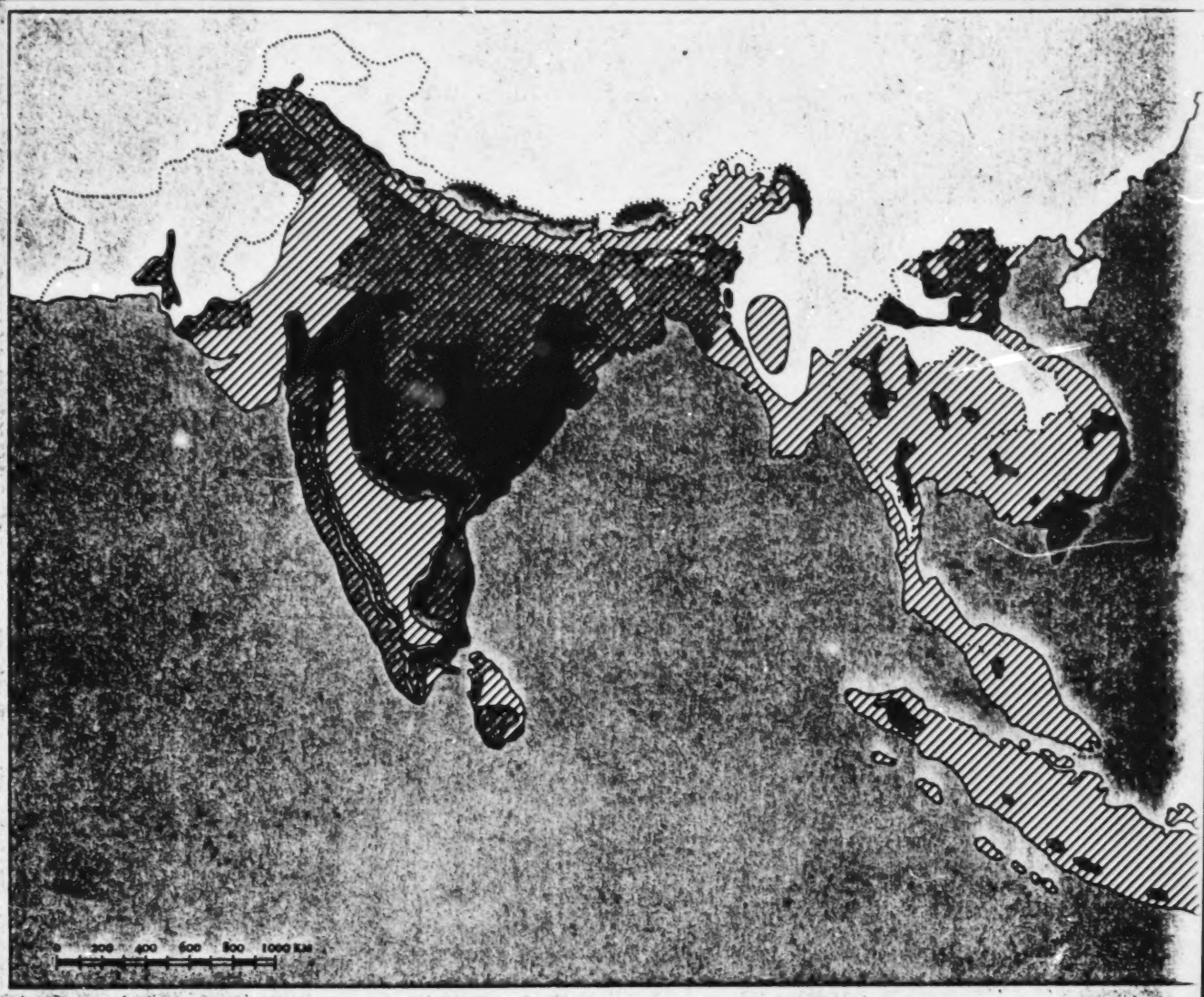
Raising inputs to the intermediate level would reduce the number of critical countries to only 12, while with high inputs only four small countries, with a population of 10 million, would remain critical. But achieving higher levels of farming will not be easy in Africa. Massive changes in cropping pattern would be needed – shifting from sorghum into maize and millet, and greatly increasing the areas under rice.



in large numbers into Zaire. Today that option is not open.

The potential is also very unevenly distributed between climatic areas. Generally, the highest *potential* population densities could be supported in the warm tropics and in the humid areas where crops have enough warmth and moisture to grow for longer periods. Yet human groups appear to have a certain aversion for such areas and actual population densities are lower. People seem to prefer to settle in cooler and somewhat dryer zones which, the study reveals, have a lower carrying capacity. The warm tropics could support more than double their 1975 populations with low inputs, while the actual populations of the cool and cold tropics (often mountainous areas) were two to six times greater than the land's carrying capacity.

The reasons for this climatic distribution of populations are not explored in the study: they relate, among other



things, to the higher incidence of human and animal diseases in hot and humid areas, the greater prevalence of hard-to-clear rain forest and ecologically sensitive soils, the difficulties of working in humid heat, and the rapid growth of weeds. Future attempts to use the unexploited potential of these areas will have to pay the greatest attention to conservation and health care provision.

Grim reading though they make, the results so far quoted, if anything, underestimate the gravity of the coming mismatch between population and land resources in many parts of the Third World. Largely for reasons of technical simplicity, the study made a number of assumptions which bias its results towards optimism. It assumed that all the land is used to grow food crops and nothing else, livestock only being raised on the land whose productivity is too marginal. Although allowance is made for non-agricultural land requirements (for housing, industry, roads and so on), none is made for land needed to grow non-food crops such as fuelwood, fibres, tea and coffee, or even green vegetables. The study allows only for a minimum recommended calorie intake, and takes no account of rising desires for meat and dairy products. It assumes, too, that food supplies are equally distributed among social groups.

In the real world several constraints operate to reduce the number of people a given area can feed. Non-food crops are essential for some basic necessities of life, and in other cases needed to sell in exchange for essential manufactured goods. As incomes rise, families spend more of their incomes on meat and dairy products, which require several times more hectares than cereals or roots to produce the same calorie output. And given the great inequality of income and food distribution in many developing countries, much more food would need to be produced to ensure that the poorest received an adequate diet.

It seems likely that, as a minimum, one-third of the land would need to be used to compensate for these factors. This would reduce all figures for carrying capacity quoted above and in Tables A and C by one third. Equally crucial is the fact that the study assumes that *all* cultivable land – a total of more than 3,000 million hectares – is brought into use. This is more than four times the present cultivated area in the countries studied of 671 million hectares. This implies an expansion of the present area by 80 per cent in Asia, by almost four times in Central America, by more than seven times in Africa and more than nine times in South America. Such an expansion, totalling nearly 2,400 million hectares, would take some 800 years at the average rate of expansion for 1974-80.

Finally, the study's first phase did not compare potential carrying capacity with

Asia

Land able to support more than one person per hectare with low inputs.

Land where the potential carrying capacity, at low inputs, is less than the present population.

Asia had the largest number of people living in critical countries in 1975, for low inputs: 770 million people, no less than 69 per cent of the regional total, in six countries out of 16 in the region.

However, only 168 million were in excess of the carrying capacity.

In terms of area, about a third of the region's total of 900 million hectares is in critical zones.

The prospects for AD 2000 are not as alarming as one might expect. There will still be six critical countries, for the low level of inputs, but their total population will be only 341 million. The improvement is entirely due to the fact that India ceases to be critical at any level of input, due to large expected increases in irrigation.

Raising the region's level of inputs to intermediate would leave only two countries critical by the end of the century. Farming inputs in most of the region are already above the low level and could easily reach the intermediate level by AD 2000 with a bit of effort. The expansion in cultivated land that is implied is more manageable than in Africa or Latin America. Fertility is declining rapidly, and alternative sources of income from industry are expanding.

But the margin for comfort is small. Even at high input levels, if one-third of the land is used for non-food crops, the region would be able to feed only 1.3 times its expected stable population, and it would be critical at low and intermediate input levels.

South Asia presents the most serious picture at low input levels: almost the whole of the region is critical for 1975. But application of intermediate inputs has a dramatic effect, cutting the extent of critical zones by four-fifths. At this level of farming, the only large extent of critical zones remaining stretch across the northern limits of the region, along the Himalayas.

South-east Asia is generally less problematic, but the region's most populous countries have widespread critical zones, including the Mekong and Red River deltas and the whole of Java. Raising the level of inputs to intermediate leaves only Java unable to support its 1975 population from its lands, while the high level of inputs greatly alleviates the problem even here.

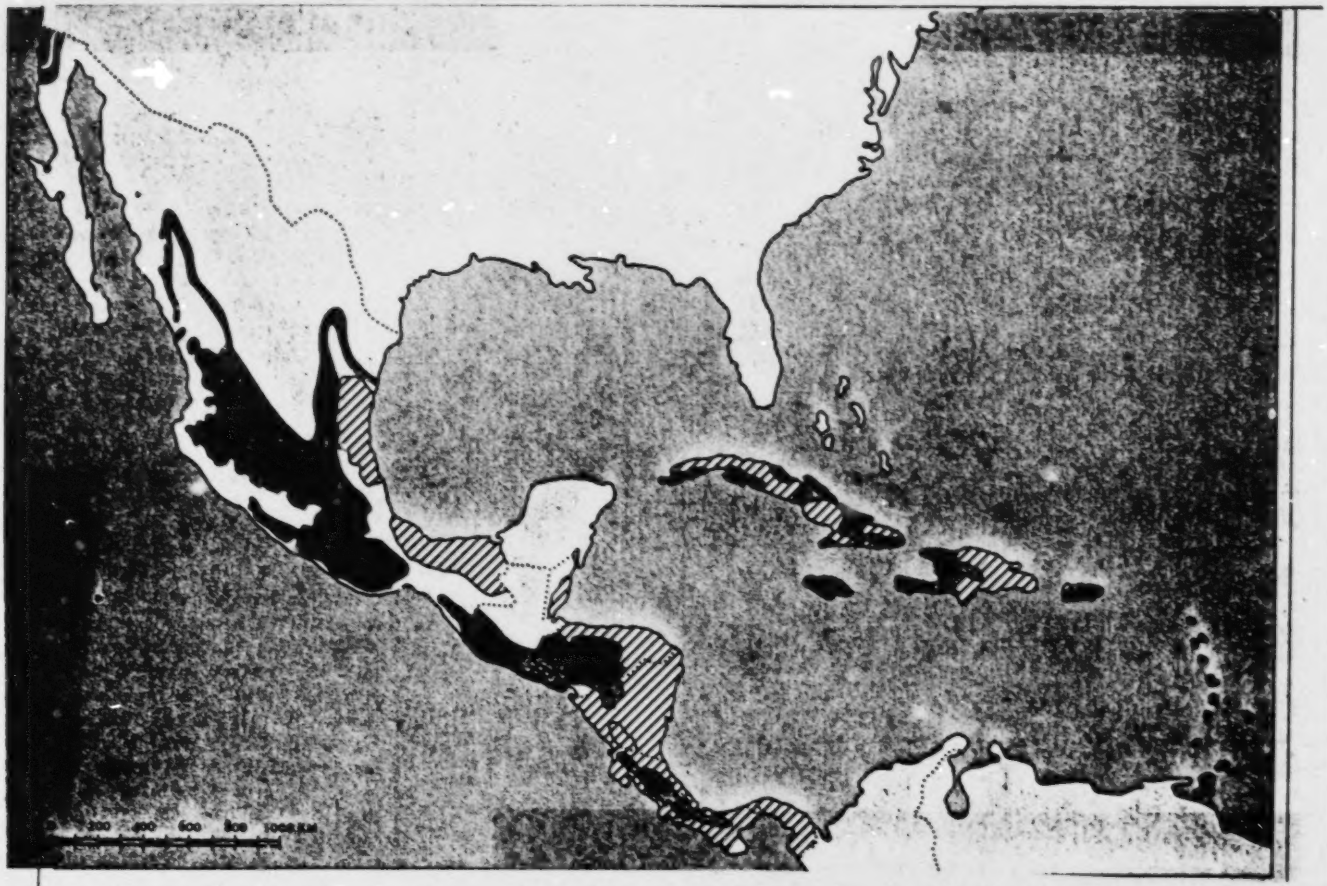
expected populations beyond the year 2000, though the eventual stationary populations, by AD 2150, may be 70 to 150 per cent higher than at the end of this century.

It is possible, however, to allow for some of these omissions. Two questions are of particular importance. One is: what was the carrying capacity of the land actually cultivated in 1975, allowing one-third for non-food needs? The results, shown in Table B, are alarming: they suggest that in 1975 the population of every developing region was in excess of the carrying capacity of the land resources, with low inputs. At this level of farming, the lands of the developing regions as a whole could sustain less than half their 1975 populations.

The fact that they did in fact support more is explained partly by higher levels of farming in commercial sectors in Asia and Latin America, partly by the massive rise in food imports into the developing countries – and partly, too, by progressive land degradation. For higher yields can be wrested temporarily from the soil by over-exploiting it, but the long-term result of that is a serious or sometimes total loss of productivity.

I have also made a provisional calculation of how the population carrying capacity compares with the expected stable populations, based on the projections by Zachariah and Vu of the World Bank. These are illustrated in Table D: they assume this time that all cultivable land is occupied, but one-third is used for non-food needs. Once again, the results give grave cause for concern.

At low input levels, every region except South America is critical. If high inputs were used, the countries studied could support about three times their expected stable populations. But, once again, this is a global figure and conceals great disparities between, at one extreme, countries able to sustain up to a ☞



hundred times their expected populations, and at the other, countries where the projected figures may, in fact, never be reached because death rates will be higher than projected because of malnutrition.

The overall prospect for the next century or so is gloomy. Two factors might intervene to improve the outlook. On the food supply side, it is conceivable that breakthroughs in agricultural techniques (such as biological nitrogen fixation by cereals) might increase the yields that could be obtained for a given level of inputs. On the demand side, it is possible that fertility may decline more rapidly than expected so that the eventual stable totals will be lower. Many countries will still be in a very bad way even if fertility does decline fast – though of course they would face more serious problems if it did not.

Hopefully, the study will help nations to face up squarely to the limitations of their land resources, and to plan their agricultural and population policies accordingly. Nations that emerge as critical will need to put every effort into raising the level of inputs into their farming, among small and subsistence farmers as well as large commercial ones. Countries that look likely to remain critical even with higher farming inputs must develop alternative sources of income in ☞

Latin America

(including Caribbean)

Land able to support more than one person per hectare with low inputs.

Land where the potential carrying capacity, at low inputs, is less than the present population.

Latin America has greater potential for food production and population-supporting capacity than any other region. The problem of critical zones unable to support their populations is largely confined to the cooler highland climates of the Andes and the mountainous spine of Central America – though some of these areas are quite densely populated, often by indigenous Indians. There are also critical areas on the northern Caribbean coast of South America (which is a very dry area), and in the parched *sertão* of North-east Brazil. Several Caribbean islands are also unable to feed their 1975 populations with low inputs.

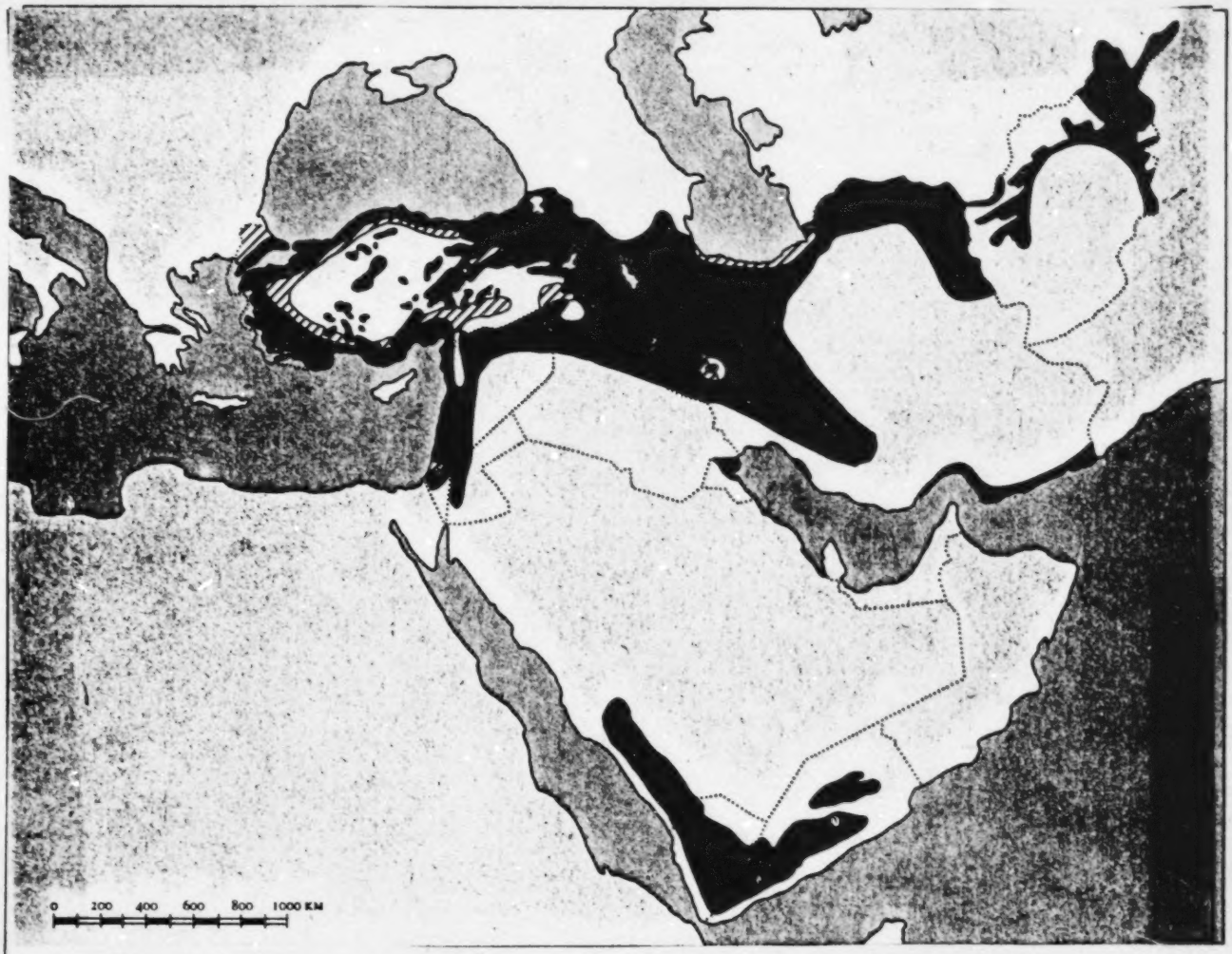
In South America, only 12 per cent of the land area is in zones unable to support their 1975 populations with low inputs, though these contain 27 per cent of the population. But none of the 13 countries is critical, either in 1975 or in AD 2000 even with low inputs.

With higher levels of inputs, South America has an enormous potential for food production. With intermediate inputs it could support its year 2000 population 13 times, and with high inputs no less than 31 times, though of course this assumes cultivation of vast tracts of Amazonia which will not, in reality, be farmed for many centuries, if at all.

Central America and the Caribbean are less favourably placed. Fourteen of this region's 21 countries would be unable to support their expected populations in AD 2000, and seven would remain critical even with intermediate inputs – six of these would be Caribbean islands. High inputs would leave only two small islands critical.

Central America and the Caribbean could support 1.4 times their year 2000 population with low inputs, 2.6 times with intermediate inputs and six times with high inputs.

The greatest single obstacle to achieving these potentials in Latin America is probably the grossly unequal distribution of land. No less than 88 per cent of the farm area belongs to the biggest 6 per cent of landowners, and a very high proportion of that (five hectares in every six, in one six-country survey) is left uncultivated.



South-west Asia

Land able to support more than one person per hectare with low inputs.

Land where the potential carrying capacity, at low inputs, is less than the present population.

South-west Asia (the Middle East) faces the most serious mismatch between population and the food-producing capacity of its lands. No less than three-quarters of the land area would be unable to support its 1975 population at low levels of inputs. With low inputs, the region would be able to feed only 70 per cent of its projected population for the year 2000. Fifteen out of 16 countries, containing 195 million people (88 per cent of the total) would be critical, and their numbers in excess of the supporting capacity would be 108 million.

The depth of the problem in AD 2000 is so great that applying intermediate inputs still leaves the same 15 countries critical, with the region as a whole able to feed only 90 per cent of its expected population.

High inputs, however, would reduce the number of critical countries to 12, containing only one-third of the regional population. Allowing one-third of the land for non-food needs, South-west Asia would remain critical even with high inputs, allowing no leeway whatsoever for the considerable increases in population expected after AD 2000.

One consolation is that many countries in the area have alternative sources of income with which to buy food imports – notably oil. However, there are several populous countries – such as Afghanistan – which do not.

foreign exchange with which to buy enough food to meet their deficits. Improving the distribution of income will also reduce the total level of food production needed to ensure a minimum food intake for everyone.

The study results should help countries to develop realistic goals for population size and distribution. It will no longer be possible for countries facing a critical future to shirk the problem by pretending it does not exist. Unless they do have a secure source of income with which to buy food imports, they will have to give greater weight to measures to reduce fertility more speedily, including family planning programmes and improvements in health – especially of women and children – education, and the status of women.

Without such measures a large proportion of developing countries will begin to pass the limits of their lands' carrying capacity – if they have not already done so. When that happens, environmental degradation on an accelerating scale will be inevitable, and widespread human suffering will not come far behind. ■

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